TITLE: METHOD AND APPARATUS FOR SPINNING FABRICS

BACKGROUND OF THE INVENTION

The present invention relates to the method and apparatus for spinning fabrics.

Presently existing horizontal axis washing machines include a stationary tub which is mounted within a cabinet structure. Extending between the tub and an access opening within the cabinet is a flexible boot seal which is attached to both the cabinet and the stationary tub. Within the stationary tub is a washing basket that is mounted for rotation. The washing basket includes holes therein for permitting washing fluid to pass from the washing basket in an outward radial direction into the tub which surrounds it.

The rotational axis of the washing basket is at an angle slightly elevated above horizontal. This results in the washing fluid within the basket residing in the lower rear portion of the washing basket. The washing basket includes a rim surrounding an access opening which is positioned closely adjacent to the flexible boot seal.

During the washing cycle the washing basket reciprocates back and forth in a rotational direction, and the clothing is tumbled within the washing basket to become washed by the fluid.

After the washing cycle is complete the washing fluid is drained from the washing basket and the washing basket begins a spin cycle wherein the washing basket rotates at a spin speed on the order of 1000 rpm. During the spin cycle, centrifugal force causes the fabrics within the washing basket to be pressed in an outward radial direction against the walls of the washing basket. This phenomenon is sometimes referred to as plastering. The rotation of the washing basket causes the washing fluid to pass through the plastered fabrics and outwardly through the holes in the walls of the washing basket.

On occasion some of the fabrics extend outwardly beyond the outer rim of the washing basket and frictionally engage the boot seal. If these fabrics are permitted to stay in this position during the spin cycle they will create friction against the stationary flexible boot seal and ultimately cause damage to the boot seal.

Therefore a primary object of the present invention is the provision of an improved method and apparatus for spinning fabrics.

A further object of the present invention is the provision of an improved method and apparatus for spinning fabrics which, when the fabrics engage the boot seal, detects engagement and terminates the spinning cycle.

A further object of the present invention is the provision of an improved method wherein the washing fluid is not drained while the washing basket rotates before the spin cycle, the washing fluid contributing to the redistribution of the fabrics within the basket.

A further object of the present invention is the provision of a method and apparatus for spinning fabrics which is economical, durable in use, and efficient in operation.

BRIEF SUMMARY OF THE INVENTION

The foregoing objects may be achieved by a method for operating a washing machine having a washing basket mounted for rotation within a stationary tub. The washing basket includes an open rim and a basket wall containing a plurality of holes therein. A quantity of washing fluid is within the washing basket and one or more fabrics are also within the washing basket. A flexible stationary boot seal is positioned closely adjacent the rim of the washing basket.

The method comprises rotating the washing basket within a stationary tub relative to the boot seal at a first rotational speed insufficient to plaster the fabrics against the basket wall in response to centrifugal force. The rotational speed of the washing basket is gradually increased to a second rotational speed which is sufficient to cause the fabrics to be plastered against the basket walls in response to centrifugal force. The rotational speed of the washing basket is increased further to a third rotational speed higher than the second rotational speed, and then is reduced back to the second rotational speed. The washing fluid is then drained from the washing basket and a spin cycle is begun. During the spin cycle the basket is rotated at a fourth rotational speed greater than the first, second and third rotational speeds and sufficient to cause washing fluid to be extracted from the fabrics and to move outwardly through the holes in the washing basket walls in response to centrifugal force.

A further feature of the present invention is the step of checking for an imbalance condition of the fabrics within the basket while the basket is rotating at the second rotational speed after the draining step.

According to a further feature of the present invention the rotation of the basket is stopped when an imbalance condition is sensed. The rotational speed is then returned to the second rotational speed.

According to another feature of the present invention the step of checking for an imbalance condition comprises sensing whether or not there is a torque change or a rotational speed change of the basket while rotating at the third rotational speed.

According to a further feature of the present invention the first rotational speed is approximately 50 rpm.

According to another feature of the present invention the second rotational speed is approximately 85 rpm.

According to another feature of the present invention the third rotational speed is approximately 100 rpm.

According to another feature of the present invention the basket is rotated at a tumble speed insufficient to cause the fabrics to become plastered against the basket wall in response to centrifugal force but instead to tumble within the basket during rotation. The washing fluid is maintained within the washing basket. The rotational speed of the basket is increased to a plaster speed sufficient to cause the fabrics to become plastered against the basket wall in response to centrifugal force. The washing fluid is then drained from the washing basket. A sensor senses whether or not the fabrics create an imbalance condition during the rotation of the basket at the plaster speed. The plaster speed is then reduced for a predetermined time interval to the tumble speed in response to sensing an imbalance condition during the rotation of the basket at the plaster speed. This causes the fabrics to cease being plastered against the basket wall and instead causes them to tumble within and be redistributed within the washing basket. The plaster speed is then resumed after the predetermined time interval and the rotational speed is then increased to a spin speed sufficient to cause the washing fluid within the fabrics to be extracted and pass out of the washing basket through the holes in the wall of the washing basket.

According to another feature of the present invention during the spin cycle a sensor senses for increased torque or reduced rotational speed of the washing basket. In response to sensing increased torque or reduced rotational speed, the washing basket is slowed to a tumble speed insufficient to cause the fabrics to become plastered against the wall of the

washing basket in response to centrifugal force but instead to cause the fabrics to tumble and be redistributed in the washing basket. The washing basket is then returned to the spin speed.

The apparatus of the present invention comprises a stationary outer tub, an inner washing basket having a basket wall, holes within the basket wall and an annular basket rim defining an open end to the washing basket. The inner washing basket is mounted for rotation within the stationary outer tub. A washing fluid is within the washing basket and a boot seal is attached to the outer tub. The boot seal is positioned closely adjacent the annular rim of the washing basket. A motor is adapted to rotate the washing basket at a tumble speed wherein the fabrics within the washing basket are tumbled but do not become plastered against the washing basket wall, at a plaster speed wherein the fabrics within the washing baskets are plastered against the washing basket walls, and at a spin speed wherein the washing fluid within the fabrics is extracted from the fabrics and exits the holes in the washing basket in response to centrifugal force. A sensor senses the combination of high torque of the washing basket and the lower than desired rotational speed of the washing basket caused by fabrics frictionally engaging the boot seal while the washing basket is spinning at the spin speed. A controller connected to the sensor and the motor causes the motor to terminate the spinning of the washing basket.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of a washing machine of the present invention.

Figure 2 is a schematic view showing the washing basket, the tub, the flexible boot seal and a portion of the cabinet, together with block diagrams showing various components in the system.

Figure 3 is a flow diagram showing the steps in the method of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the drawings, the numeral 10 generally designates a washing machine made according to the present invention. Washing machine 10 includes a cabinet 12 having a front door 14. The front door 14 includes a nose 16 which projects inwardly when

the door is closed. The door is hinged to close over an access opening 18 having a boot seal 20 surrounding the access opening 18.

A detergent dispenser 22 is provided in the top of the washing machine 10 for introducing detergents and the like to the interior of the washing machine 10. Washing machine 10 also includes a control panel 24 having selector buttons 26, 28, 30, and 32. The control panel 24 also includes a control knob 34.

Mounted for rotation within the cabinet 12 is a wash basket 36 having holes 38 in its peripheral wall. Wash basket 36 also includes a plurality of fins or blades 40 protruding inwardly from its peripheral wall for tumbling the fabrics within the washing basket 36 during the time that the washing basket 36 is rotating.

Surrounding the washing basket 36 is a stationary tub 42 (Figure 2) which is mounted within the cabinet 12. The stationary tub 42 includes an open upper end 43 to which is attached the boot seal 20. Boot seal 20 includes an inner end 46 which is attached to the open upper end 43 of tub 42. Also boot seal 20 includes an outer end 48 attached to cabinet 12 and a fold 50 between inner end 46 and outer end 48.

Washing basket 36 includes an annular rim 52 which is positioned adjacent the open upper end 43 of the tub 42. This annular rim 52 forms a basket opening 54. Within basket 36 is a washing fluid 56 which contains a plurality of fabrics 58.

A motor 60 is connected to the transmission 62 for rotating the washing basket 36. A speed sensor or tachometer 64 is connected to the motor 60 for sensing the rotational speed at which motor 60 is operating. Speed sensor 64 is also connected to a controller 66. The controller 66 is also connected to a drive controller 67 which in turn is connected to motor 60. A drive torque sensor 65 senses the torque on motor 60 and provides feedback from the drive controller 67 to the controller 66. The purpose of drive torque sensor 65 and speed sensor 64 is to detect an unbalance condition or frictional engagement of fabrics on boot seal 20 in the manner described below as to Figure 3.

A drain pump 68 is connected by conduit to the lower most region of tub 42 for draining washing fluid 56 out of the washing basket 36 and the tub 42. The fluid 56 communicates from within the washing basket 36 to the tub 42 through the holes 38 (Figure 1). A drain sensor 70 of the pressure sensitive type commonly used in washing machines is designated by the numeral 70 and is connected to the drain conduit leading to

the drain pump 68. All of the drive controller 67, the torque sensor 65, speed sensor 64, the drain pump 68, and the drain sensor 70 are connected to the controller 66.

Referring now to Figure 3, a flow diagram shows the transition from the washing cycle through the spin cycle. To begin the transition the washing basket is rotated in one direction at a tumble speed or first speed of approximately 50 rpm. The rotational speed may vary without detracting from the invention, but the rotational speed should be a "tumble speed". The term "tumble speed" refers to a rotational speed which causes the fabrics to tumble within the washing basket 36 without being plastered against the side walls of the washing basket 36 by centrifugal force.

In preparing for the spin cycle the rotational speed is increased from 50 rpm to approximately 85 rpm as designated by the box numbered 72. At 85 rpm the fabrics are plastered to the wall of the washing basket 36. Thus the rotational speed is increased from the tumble speed or first speed to a plaster speed or second speed sufficient to plaster the fabrics against the walls of the washing basket 36. It is to be noted that the washing fluid 56 remains in the basket during this step.

The box 74 reflects the next step of the process. The washing fluid still remains in the washing basket 36, and the rotational speed is increased to a higher plaster speed or a third speed of approximately 100 rpm. This higher plaster speed is maintained for approximately 30 seconds. The speed of the higher plaster speed and the time period for maintaining this higher plaster speed may vary without detracting from the invention.

Next, the drain pump 68 is turned on to drain the washing fluid 56 from the washing basket 36 and the outer tub 42. The rotational speed of the washing basket 36 is reduced to the lower plaster speed or second speed which is approximately 85 rpm. The turning on of the drain pump 68 is designated by box 76 and the reduction in speed to 85 rpm is designated by the box 78.

Throughout this process the controller 66 controls the operation of the motor 60, the drive controller 67 and the drain pump 68.

The box 84 shows a testing of the drain time. If the drain time equals or exceeds 60 seconds the process moves on to box 80. The box 80 reflects a sensing operation that is conducted by drain sensor 70 to determine whether or not the drain is complete. If the drain sensor senses that the drain is not complete, the drain time is extended as reflected by

box 82. Box 84 reflects a determination of whether or not the drain time equals or exceeds four minutes. If it does, the controller 66 shuts the machine down as reflected in box 110. Otherwise the draining continues until complete and the controller 66 moves to the next step of the process.

This next step is reflected by box 86 and involves checking whether or not the basket is in an unbalanced condition. Such unbalanced conditions occur when fabrics within the washing basket 36 are unevenly distributed within the washing basket 36. It should be noted that the rotational speed of the washing basket remains at approximately 85 rpm or at the first plaster speed.

The controller 66 detects an unbalance condition through both the drive torque sensor 65 and the speed sensor 64. Controller 66 sends an electrical signal to the drive controller 67 which responds by driving motor 60 at the desired speed which is 85 rpm. The drive torque sensor senses the current necessary to keep motor 60 operating at the 85 rpm, and feeds this information back to the controller 66. The current needed to drive motor 60 is related to the torque on motor 60. If an unbalance condition occurs the basket exhibits a high torque while lifting the unbalanced load and a reduced torque when the load drops. The drive torque sensor 65 senses this fluctuation in the current/torque and feeds that information back to the controller. In addition, the speed sensor 64 detects fluctuations in speed of the rotation of motor 60.

If the torque or speed sensor 64 senses an unbalanced condition, the controller 66 stops the rotation of the washing basket as reflected by the box 88. After the rotation has been stopped it is again increased to the tumble speed of 50 rpm as designated by the numeral 90. The rotational speed is then gradually increased to 85 rpm as indicated by box 91. The box 92 reflects the addition of a number to a counter. The box 94 reflects checking for the counter to determine whether or not the counter has exceeded a predetermined number indicated as "X". This feature prevents the washing machine from continuing indefinitely in this cycle if the imbalance condition persists. If the number in the counter exceeds "X" the machine is shut down as shown by box 96. Otherwise the method continues back to box 86.

In most situations the stopping of the rotation and the renewed increasing of the rotation to the first plaster speed will cause the fabrics to redistribute within the basket 36 and will eliminate the unbalance condition.

If no unbalance condition is sensed, or if it is corrected by the process described above, the controller causes the washing basket to move into the high spin speed process as indicated at box 98. During the spinning operation, the spin speed or fourth speed of the washing basket is sufficient to cause the fabrics not only to be plastered against the walls of basket 36 but also causes the extraction of the liquid from the fabrics through holes in washing basket 36. The preferred ultimate or maximum spin speed for the washing basket 36 is approximately 1000 rpm, but this may be varied without detracting from the invention. During the spinning process the washing basket 36 may be rotated at numerous spin speeds for periods of time.

During the spin cycle, even though there may not be an unbalance condition, it is possible that the fabrics 58 may extend outwardly beyond the rim 52 of the washing basket 36 and may engage the boot seal 20. High speed rotation of the washing basket 36 causes these fabrics to wear against the boot seal 20 and thus cause damage to the boot seal 20. This condition is shown schematically in Figure 2 by the fabric 58 which contacts the boot seal 20.

If fabrics 58 frictionally engage boot seal 20 then speed sensor 64 detects a reduction (box 100) in rotational velocity of washing basket 36 and torque sensor 65 senses (box 102) an increase in torque caused by the friction. Drive torque sensor 65 senses whether or not the torque has increased above a threshold level as represented by box 104. Then the controller determines if the time of increased torque above the threshold has existed for more than thirty seconds (box 106). If so the machine shuts down as indicated by box 108, but if not the high speed spin continues. If there is no frictional engagement between the boot seal 20 and the fabrics 58, the spin cycle continues until it is over as indicated at box 110, and the machine shuts down as shown in box 112. Testing of the completion of the spin cycle is usually done by a timer which times the length of the spin cycle.

While the rotational speeds of 50 rpm, 85 rpm, 100 rpm, and 1000 rpm are the preferred rotational speeds for the tumble speed or first speed, the lower plaster speed or

second speed, the higher plaster speed or third speed, and the spin speed or fourth speed, these various rotational speeds may be varied without detracting from the invention. The tumble speed refers to a speed which causes rotation of the basket 36 but causes the fabrics to tumble rather than to plaster against the walls of the washing basket 36. The lower and higher plaster speeds refer to rotational speeds which cause the fabrics to be plastered against the walls of the washing basket 36. The spin speed refers to a rotational speed sufficient to cause not only the plastering of the fabrics against the walls of the washing basket 36, but also to cause the washing fluid to be extracted outwardly from the fabrics through the holes in the washing basket 36 and through the drain provided by drain pump 68. The desired maximum spin speed is 1000 rpm. However, the testing for the fabrics 58 rubbing the boot seal 20 designated by boxes 100, 102 and 104, occurs at approximately 675-800 rpm.

In the drawings and specification there has been set forth a preferred embodiment of the invention, and although specific terms are employed, these are used in a generic and descriptive sense only and not for purposes of limitation. Changes in the form and the proportion of parts as well as in the substitution of equivalents are contemplated as circumstance may suggest or render expedient without departing from the spirit or scope of the invention as further defined in the following claims.